EXECUTIVE SUMMARY

INTRODUCTION

This plan analyzes flooding problems and potential solutions along the six major rivers that flow through King County: the Skykomish, Snoqualmie, Cedar, Sammamish, Green, and White. In just the short period since 1986, flooding along these rivers has caused tens of millions of dollars in damages to public and private property, resulted in the deaths of several people, damaged or destroyed hundreds of homes, and killed scores of livestock. This recent cycle of flooding reached its most severe point with the historic Thanksgiving 1990 Flood, which exceeded all previous flow records on most of these rivers and caused more than $15 million in damage in King County.

To address these problems, this plan includes: 1) policies to guide floodplain land use and flood control activities in King County; 2) program and project recommendations, including capital improvement projects, maintenance, relocation and elevation of homes, and floodwarning improvements and river planning activities; 3) implementation priorities for program and project recommendations; and 4) an analysis of major financing alternatives and issues.

SCOPE OF THE PLAN

Although flooding occurs along many different types of water bodies and drainage systems in King County, the scope of the plan is limited to the County's six major river systems and their tributary areas in the eastern two-thirds of the County (see Figure 5 in Section 1).

King County addresses flooding problems along these major rivers through a specific program and funding source: the River Management Program, which is funded from a Countywide property tax levy called the River Improvement Fund (RIF) levy. The RIF levy is part of the County's overall property tax assessment and is collected from both incorporated and unincorporated properties. The River Management Program is administered by the County's Surface Water Management (SWM) Division.

In the western one-third of the County, characterized by small, urbanizing stream basins, drainage problems are addressed through a separate program, the SWM Program. The SWM Program, which is also administered by the SWM Division, is funded by a service charge based on the amount of impervious surface area (pavement, rooftops) on properties in unincorporated King County. The program deals primarily with urban drainage issues and the impacts of development on small streams in the western third of the County.

This plan addresses flooding problems in both incorporated and unincorporated areas along the major rivers, but only if they are related to flooding along a river or stream (as opposed to an urban drainage problem). Although many of the specific recommendations in the plan are directed at King County,

they will be most effective if adopted on a basinwide basis, with the full cooperation of cities, neighboring counties, and agencies. It is therefore intended that this plan provide solutions that other jurisdictions can use and benefit from as well, and which can be implemented in close cooperation with them.

GOALS OF THE PLAN

Goals for the plan were developed at the beginning of the planning process through a scoping meeting with federal, state, and local agencies, cities and other counties, and local tribes; through a series of "open house" workshops with citizens; and through interviews with County staff from the SWM and Roads and Engineering Divisions. The large number of issues raised at these meetings were then reviewed and broken into categories that became goals and objectives for the plan.

Three major goals were identified for the plan. They are:

1. The reduction of flood-related hazards and damages.

2. The reduction of environmental impacts of flood control.

3. The reduction of the long-term costs of flood control and floodplain management.

The success of the plan, once implemented, should be measured by the degree to which these goals have been met.

FLOODING DAMAGES AND IMPACTS IN KING COUNTY

King County has been hit extremely hard by floods recently, resulting in the federal government declaring the County a flood disaster area four times in only five years--in January and November 1986, and January and November 1990. Estimates of public sector and individual damages for these floods totaled nearly $34 million.

Over $21.5 million of this amount is accounted for by damages to public property--e.g., roads, bridges, and river facilities. In 1990, damages to flood control facilities (such as levees) accounted for roughly half of all flood damages to public property; damages to roads and bridges accounted for about one-third of total public sector damages. Private property has also been very heavily impacted by recent floods, with estimated damages in excess of $12 million since 1986. Over 1,200 homes in King County were either damaged or destroyed during the five-year period from 1986 through 1990.

It is important to note that all of these damage estimates are low. First, they include only severe floods which receive a federal disaster declaration. They do not include any figures for smaller,

"undeclared" floods. If damage from all flood events in the County were routinely tabulated, total damage in any given year would certainly be higher than these figures show.

Second, the figures are based on "preliminary assessments" conducted by the Federal Emergency Management Agency (FEMA). These assessments underestimate actual flood damages, sometimes by a large margin. This is because the purpose of the assessment, which is conducted immediately after a flood, is to determine whether damages meet the minimum threshold for a Presidential disaster declaration. Once threshold levels have been met, the assessment either stops or moves very quickly, so that many damages are never recorded.

In addition to causing extensive property damage, flooding on King County's major rivers--which can generate deep, fast-flowing water and debris over wide areas--is an obvious threat to life and limb. Fortunately, despite the potential for injury and death, there have been few flood-related fatalities in King County since the turn of the century. However, the 1990-1991 flood season was particularly severe and tragic, claiming the lives of four people (three on the Snoqualmie River or its tributaries; one on the Green River).

PAST AND CURRENT COUNTY EFFORTS TO REDUCE FLOOD HAZARDS

River Management Program

King County has spent millions of dollars trying to reduce future damages and protect public safety along its major rivers. Most of these efforts have occurred through the County's River Management Program (formerly the "River Improvement Program"), established in 1960 and currently administered by the SWM Division.

The program was established after major flooding on the Green and Snoqualmie Rivers in 1959, when King County voters approved two bond issues of $5 million each (in 1960 and 1964) to improve flood control along the County's rivers. These funds supported an aggressive and wide-ranging flood control program throughout the 1960s and 1970s. During this period the program focused primarily on three types of activities: construction of capital improvement projects (CIP), maintenance of CIP and river channels, and flood warning and emergency response.

Since exhaustion of the bond funds in the early 1980s, the only source of County funding for river flood control has been the RIF levy. The RIF levy is part of the County's General Levy, which cannot exceed certain limits set by state law. Thus, all County services funded by the General Levy, including police, jails, health services, and river management, compete with one another for a share of this limited funding.

Because of this funding restriction, the average annual budget for the River Management Program has declined dramatically since exhaustion of the bond funds. If the program's budgets from the 1960s are converted to 1992 dollars, the current level of expenditure for the program (which averages $2

million a year) represents only about one-fifth to one-sixth of the average budget in the 1960s. Thus, activities undertaken by the program have been very limited compared to what they once were.

For example, funding limitations have not permitted the construction of new CIPs in recent years. Maintenance has been restricted to high-priority projects, namely those that protect public property and those that the County is obligated to maintain through written agreement. Logjam removal and dredging, considered maintenance activities, have also diminished under this restriction. In addition, all of these activities have been constrained by tougher environmental requirements that have been adopted since the early 1970s.

Some planning activities have been funded under the program, but these have been largely in support of efforts by other agencies and jurisdictions, especially the U.S. Army Corps of Engineers (Corps). These efforts have covered a patchwork of diffuse geographic areas and issues, including levee improvements on the lower Green River, participation in a Corps flood hazard reduction study for the City of Snoqualmie, and a study of the potential for improved flood control operations of the Masonry Dam on the Cedar River.

In sum, the current program is limited to a responsive, "fire fighting" mode that responds to high-priority damages but can do little to prevent those damages from recurring.

Development Regulations and Land-Use Plans

King County has recently adopted a number of important development regulations and land-use plans to try to prevent the creation of additional flood problems. Recent land-use plans prepared by the County have, for example: restricted floodplain development to rural densities; supported the preservation of wetlands, stream corridors, and the natural flood storage of the floodplain; and, in some cases, downzoned or placed special development restrictions on large areas of the basin to reduce the downstream impacts of development.

Most significant from a floodplain management perspective, however, is King County's *Sensitive Areas Ordinance* (SAO), adopted in 1990. In addition to regulating the use and protection of wetlands, stream buffers, and areas subject to natural hazards, the ordinance contains the County's floodplain regulations. These regulations are among the most stringent in the United States. Some of their most significant requirements include:

- New development in the floodplain cannot block the flow of floodwaters such that it would cause water to back up and increase flood depths on upstream properties (the "zero-rise floodway" requirement).

- New development in the floodplain cannot reduce the floodplain's ability to store and slowly release floodwaters, since this storage helps reduce impacts to downstream properties (the "compensatory storage" requirement).

- The first floor of new or rebuilt development in the floodplain must be elevated one foot above the 100-year flood; areas below the first floor must allow for the passage of floodwaters.

- In areas where the "future conditions flow"--i.e., the streamflow expected after the basin has been fully developed--has been calculated and approved through adoption of a basin plan, that flow should be used to determine the boundaries of the regulated floodplain.

Another very significant set of regulations adopted by King County in 1990 is contained in the *Surface Water Design Manual* (King County 1990a). The manual describes requirements for the detention and conveyance of stormwater runoff from developed sites, and is intended to minimize the impact of development on natural and constructed drainage systems.

REMAINING ISSUES AND NEEDS

Through land-use plans and development regulations, King County has taken major steps to prevent the creation of new flood problems. In fact, the County is considered a national leader in the use of these types of policy and regulatory measures, which should significantly reduce the number of new, at-risk structures in flood hazard areas.

Even when these measures have had the time to make an impact, it is important to emphasize that they are only *preventative* solutions. They are directed at proposed new developments, and are intended to minimize the creation of new flood and erosion problems. They will not, however, solve flooding and erosion problems for structures that have already been built in hazardous areas. From a floodplain management perspective, the protection of these existing structures remains the primary challenge now facing the County.

The County's current River Management Program is not sufficiently funded to seriously address existing flooding problems. Furthermore, even if funding were available, the program lacks a comprehensive, long-range plan for how to reduce flood hazards along the major rivers. The last such plan, King County's *Comprehensive Plan for Flood Control* (King County 1964), is badly out of date both in terms of content and floodplain management philosophy. A new, comprehensive plan for addressing this problem is needed, along with the funding to implement it. This plan is intended to address these needs.

MAJOR FEATURES OF THE PLAN

This *Flood Hazard Reduction Plan* (FHRP) attempts to fill the need for a long-range flood protection plan for the major river systems. Apart from the first two sections of the plan, which provide introductory and background information, the plan consists of the following major sections:

Policies

The plan proposes a set of policies to direct floodplain and watershed management activities within King County. The policies provide operating principles to guide the County's flood hazard reduction efforts over the long term. They do not describe exactly what should be done in terms of projects and programs, but instead give the general rules by which those projects and programs should be implemented.

The policies are divided into a number of categories. They include some policies already adopted by King County, either in previous plans or in the SAO, and some that are new. Both existing and new policies were included in order to form a single document describing all the County's floodplain management policies.

Most of the policies dealing with floodplain land use are already embodied in the SAO. The most notable set of new policies is the one addressing how flood hazard reduction projects should be selected, designed, built and maintained. Significant issues addressed by this set of policies, titled "Flood Hazard Reduction Project Policies," include the following:

- What types of property should be eligible for assistance from the River Management Program? Are there any circumstances, for example, when private property should be protected, or should the program be limited to protecting public property (e.g., roads, bridges, parks)?

- How should flood problem sites be prioritized? Is a threat to a public road or bridge more important than the threat to several homes? How should the County spend its limited resources?

- What criteria should be used to evaluate alternative solutions? How should environmental protection, the benefits and costs of the project, and other issues be weighed in this evaluation?

- What level of protection should be provided by flood control projects built or maintained by King County? That is, should these projects protect against the 100-year flood, or some lesser (or greater) event?

Also significant are the proposed "Interjurisdictional Consistency Policies," which describe how the policies of this plan would be applied to incorporated areas.

Program and Project Recommendations

This section of the plan describes programs and projects needed to prevent new at-risk development, and to reduce flood and erosion hazards to existing development.

The program and project recommendations include eight major elements. These include both improvements to current activities performed by the River Management Program and new activities:

- *Structural Capital Improvement Projects* (levees, bank stabilization projects, and other structural flood control);

- *Relocation and Elevation Projects* (projects to relocate, purchase and demolish, or elevate endangered homes in floodplain areas);

- *Maintenance and Monitoring* (repair and maintenance of projects and channels; ongoing monitoring of channels and the effectiveness of structural flood control);

- *River Planning* (studies, plans, and hazard mapping along the major rivers for use in project selection and design and land-use regulation);

- *Flood Hazard Education* (educational materials and events to increase public awareness of flood hazards, regulations, and programs);

- *Flood Warning and Emergency Response* (issuing flood warnings, patrolling levees and other flood control projects during the flood, providing sand and sandbags to private residents, and conducting emergency repairs);

- *Complaint Response and Enforcement* (ongoing response to complaints, pursuit of enforcement actions when necessary, response to claims and lawsuits); and

- *Interlocal Coordination* (developing interlocal agreements with other jurisdictions in the major river basins to ensure consistency and cooperation, providing technical assistance to cities).

The wide range of projects and programs described in this section are intended to address known flooding and erosion problems on the major rivers. The cost of addressing all these needs, however, is enormous: total annual need (project or programs that would be conducted an annual basis) is estimated at $3.4 million; total one-time need is estimated at $324 million.

Funding does not exist to implement all of the recommendations identified in this plan. Therefore, the County Council will need to provide direction on the overall priorities for implementation.

Table 1 gives the total one-time and annual costs of the different program elements. Table 2 shows the total identified need for capital projects in each of the major river basins.

TABLE 1

TOTAL IDENTIFIED NEED FOR FLOOD HAZARD REDUCTION PROGRAMS AND PROJECTS

Program/Project	One-time Cost	Annual Cost
Structural Capital Improvement Projects	$265,000,000	$300,000
Relocation and Elevation Projects	$53,500,000	$240,000
Maintenance and Monitoring	$383,000	$2,400,000
River Planning	$4,850,000	$0
Flood Hazard Education	$106,000	$15,000
Flood Warning and Emergency Response	$97,000	$62,000
Complaint Response and Enforcement	$0	$216,000
Interlocal Coordination	$64,000	$15,000
Administration	$0	$150,000
Total	$324,000,000	$3,400,000

TABLE 2

TOTAL IDENTIFIED NEED FOR CAPITAL PROJECTS, BY MAJOR BASIN

River Basin	Structural CIP Cost (millions)	Relocation Elevation Cost (millions)	Total Cost (millions)
Skykomish	$9.3	$10.3	$20
Lower Snoqualmie	$30.3	$5.1	$35
Upper Snoqualmie	$23.8	$16.0	$40
Sammamish	$14.5	$0.0	$15
Cedar	$46.5	$21.3	$68
Lower Green	$113.0	$0.2	$113
Upper Green	$18.4	$0.0	$18
White	$9.3	$0.7	$10
Total	$265	$53.5	$318

- totals may differ slightly due to rounding

Development of these recommendations included an intensive survey of problem sites following the November 1990 floods. Engineering staff from the SWM Division spent several months in the field in 1990-1991 collecting data and evaluating damages from the floods. This evaluation resulted in detailed problem analyses and project recommendations for over 123 flood-damaged sites in King County. These analyses, which are the basis for the structural CIP and relocation and elevation project recommendations in the plan, are found in *Appendix B: Problem Sites and Project Recommendations* (King County 1993), which has been published as a separate document.

The proposed program and project recommendations include a number of major new initiatives. The most important of these, both in terms of cost and policy significance, are summarized below.

Relocation and Elevation Projects

Most notable among the new activities proposed in Section 4 is the relocation or elevation of homes in flood hazard areas. This is a major new initiative that has never before been funded by the County. Relocation and elevation are usually cost-effective and permanent solutions to flooding, especially in low-density areas. They have none of the ongoing repair costs associated with structural CIPs, can increase flood storage and conveyance capacity, and, in the case of relocation, create public open space areas along the major rivers.

New Standards for Capital Improvement Projects

Another major new initiative in the work program is the use of new standards for the design, construction and maintenance of capital projects. These new standards would protect or enhance fish and wildlife habitat, reduce maintenance costs per project, and minimize impacts to flood storage and conveyance.

For example, almost all new bank stabilization projects (i.e., projects built to reduce erosion of the streambank) would incorporate a technology known as soil biostabilization rather than a traditional design of bare, broken rock (called riprap) covering the bank. Biostabilization projects consist of layers of specially developed natural and synthetic materials, soils and vegetation (an example of this type of project is shown in Figure 4 in the Foreword). Together, these layers create a complex grid of different materials in the bank which are very resistant to erosion. The vegetation in the project establishes roots which further stabilize the bank, while at the same time improving habitat for fish and wildlife.

Proposed levees (i.e., berms of earth built parallel to the river to contain flood flows) would also be designed differently than in the past. Traditionally, levees have been built right next to the channel, and kept bare of almost all vegetation. However, forcing flood flows through a narrow, leveed corridor can cause floodwaters to back up and increase flood depths upstream, creating a need for even more levees. Traditional levees can also reduce flood storage (i.e., the ability of the floodplain to hold and slowly release floodwaters), thus increasing stream velocities and erosion downstream. Placing levees right on the banks of the river also increases maintenance costs, because the depth of water (and amount of erosion) on the face of the levee is greater than it would be if the levee were further away from the channel. Finally, the current maintenance practice of removing most vegetation from the faces of levees diminishes fish and wildlife habitat.

In contrast, new levees would be set back, away from the river channel, with a vegetated "bench" along the river (see Figure 17 in Section 4). Excavation along the riverward side of the levee would minimize any upstream or downstream flooding impacts. The base of the project would be supported by heavy rock, set into the bed of the channel (a rock toe key.) This design provides a wide flood storage and conveyance area, habitat for fish and wildlife, and minimizes undercutting and erosion of the levee.

These standards would apply not only to new projects being proposed, but to existing projects as well. Maintenance standards, for example, would be changed to encourage vegetation on the faces of levees and bank stabilization projects.

The work plan also recommends major improvements (retrofits) to existing facilities. Retrofits are intended to reduce County maintenance costs, improve public safety, reduce flood damages and/or improve habitat. Roughly half of the structural CIPs proposed in the plan are retrofits to existing facilities. This is a major departure from current County maintenance standards, which usually result in projects being returned to their original design.

It is important to note that the fact that CIP are proposed at all represents a major expansion of the County's current flood control efforts. This plan identifies a total of $318 million in capital needs along the major rivers. This total includes approximately $53.5 million in home relocation and elevation projects. Of the $318 million total, $72.3 million is associated with projects classified as "high" priority. Since no new flood control CIP have been built along the County's major rivers since the 1970s, this would represent a huge expansion of past and current efforts.

Improved Coordination with Cities and Other Counties

The work plan also emphasizes improved coordination with cities in King County, and with Pierce and Snohomish Counties. Because what one jurisdiction does in the floodplain can increase backwater flooding or erosion in another jurisdiction, cities and counties clearly have an interest in each other's floodplain management.

Two recent pieces of state legislation, the Growth Management Act (RCW 36.70A) and the "Flood Bill" (RCW 86.12) strengthen requirements for interlocal consistency and coordination. To implement these requirements and improve regional floodplain management, the work plan recommends a King County-staffed technical assistance program to help cities develop similar flood hazard policies, regulations, and programs.

Implementation Priorities

The total need for programs and projects described in this plan far exceeds existing funding resources. Therefore, the County Council will need to provide direction regarding the overall priorities for implementation. For example, the County Council may choose to consider focusing

limited resources on specific basins, or targeting high priority needs within each basin across the County.

In order to aid in County Council consideration of these issues, this plan includes a section describing the flood and erosion problems unique to each of King county's six major river basins, as well as priorities for problem prevention and new capital projects. These problem prevention priorities are based on an application of the goals of this plan to the characteristics and critical needs in each basin. The project priorities are based on the "Flood Hazard Reduction Project" policies recommended in this plan.

Financing

The proposed work plan is designed to address all significant flooding problems along the major rivers. However, the cost of implementing all of these recommendations far exceeds existing County funding sources. Even if only the highest priority program and project recommendations were to be implemented, new funding sources will have to be developed.

Currently, the main financial support for King County's River Management Program is the RIF levy, a property tax levy charged to all property owners in the County. In 1992, the RIF levy generated approximately $1.5 million for flood control activities. When combined with the state and federal grants as well as Green River Flood Control Zone District revenues, the funding for 1992 totaled approximately $2.8 million.

Federal funds are also sometimes available after major flood disasters. In 1991, for example, King County received over $900,000 to repair levees and other flood control facilities damaged in the November 1990 floods. However, these federal funds cannot be relied upon as a regular source of funding for the River Management Program. First, they are restricted primarily to the repair of existing flood control facilities. Other types of activities--such as construction of new structural CIPs or relocation and elevation of homes--are not generally eligible for assistance. Second, these funds are available only after a Presidentially declared flood disaster. Therefore, they are not available on a regular, ongoing basis.

Given the magnitude of the need for river management programs and projects, and the fact that disaster assistance funds do not provide an ongoing source of funding, any significant implementation of the recommendations in this plan would require the establishment of new funding mechanisms.

This plan includes descriptions of the financing mechanisms which have the greatest potential for funding the recommendations of this plan. Because it is likely that the ultimate approach for financing will rely on a mixture of mechanisms, the plan also describes which elements would be most appropriately funded by each funding mechanism. For example, many of the relocation recommendations in this plan would create public open space and river access. A countywide open space bond issue may be appropriate to fund some of the relocation and acquisition

recommendations along rivers where park and open space objectives can also be accomplished.

Before the establishment of new mechanisms can occur, there are several issues that need to be addressed by the County Council. For example, the bulk of River Management activities have historically been funded by residents from throughout King County, regardless of whether they received direct benefits from these services. Prior to any major expansion of River Management efforts in King County, a justifiable rationale needs to developed for allocating the costs of River Management efforts to County property owners.

The *Draft FHRP* (King County 1991a) posed the following question: should the costs of river management and flood hazard reduction efforts be funded by all County residents, or by residents of the basins which receive direct benefits from this services? On the basis of responses received at public meeting, this plan describes potential criteria for determining who should pay for river management services.

The other major financing issue addressed by this plan is that of integrating the River Management Program with the SWM Program (which addresses urban stormwater problems in the western third of the County). The River Management Program and the SWM Program overlap in the western third of the County where the Cedar, White, Sammamish, and Green Rivers pass through the SWM Service area (see Figure 5 in Section 1). The administration and funding of these two programs has historically been separate, however, leading to confusion among residents of areas where the overlap occurs. Many benefits could be gained from better integrating the two programs, including more cohesive and efficient surface water management services.

CONCLUSION

King County's major river systems are some of the most magnificent natural resources in the County. They provide recreational opportunities as well as habitat for fish and wildlife. Many communities in King County had their origins along the major river systems. At the same time, the major rivers can be hazardous for residents who live and work in the rivers' floodplains.

With the adoption of the King County *Sensitive Areas Ordinance* (SAO) in November 1990, King County enacted some of the most progressive river and floodplain management regulations in the Country. Rigorous application of flood hazard regulations will help to prevent new development in areas at-risk to flood and erosion hazards.

The policies contained in this plan, if adopted by the County Council, would compliment the SAO, as well as provide long-term direction for river management efforts in King County. Even in draft form, this plan has brought several benefits to County residents:

- This planning effort, along with stricter flood hazard regulations and a well established flood warning and emergency response program have enabled King County to be one of the few communities nationally to qualify its residents for reduced flood insurance rates.

- King County was one of only a handful of jurisdictions to receive scarce federal funding for acquisition and relocation of severely damaged homes after the November 1990 flood disaster. The award of funding was due in large part recommendations in the *Draft FHRP* for relocation of homes.

- More recently, King County received preliminary approval of $2.1 million in Federal and state grant funds for four major flood hazard reduction projects. The grant applications were developed using information compiled for this plan.

County Council adoption of the policies in this plan would increase the potential for these benefits continuing in the future. More importantly, it would establish a framework for all future flood hazard reduction efforts in King County. Because of recent changes in state legislation, adoption of these policies by the County Council would establish a consistent standard for flood hazard reduction throughout the County, in both incorporated and unincorporated areas.

While the benefits of timely adoption of the policies cannot be overemphasized, without additional funding, King County will continue to lose ground in preventing damages to existing development in King County. Current funding levels do not provide sufficient revenue to support the design and construction of new capital projects. Of even greater concern is the county's inability to keep up with regular maintenance of existing river facilities such as levees and revetments. Nor can the county implement modifications to these facilities that would make them less susceptible to damage.

It is the recommendation of this plan that the scope of River Management activities should be expanded beyond current levels in accordance with the recommendations and priorities described in this plan. However, the timing of this expansion needs to follow Council consideration of the following issues:

1. Which basins and/or recommendations are considered to be the highest priorities for funding and implementation?

2. If the scope of the River Management Program is expanded, how should the costs of implementation be shared by County residents?

3. To what extent should the King County River Management Program and SWM Programs be integrated?

This plan addresses each of the above issues in detail.